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ABSTRACT

Five economic hypotheses of what American universities value (profit, production, prestige, faculty consumption, or academic resources and activities) were tested to illustrate the implicit value framework, a conceptual framework for inferring the objective economic values of an organization from the manner in which society has defined its relationships of exchange and production. The population for the study was comprised of 166 comprehensive and research-doctoral universities and the time period was the 1982-83 academic year. Since a period longer than one year is needed to produce graduates, cross-sectional data were used. The universities were divided into four types: selective-private, selective-public, less selective-private, and less selective public. Data on several other variables were collected: inputs and outputs (students, degrees granted, articles published), faculty, departmental and administrative services, library services, and physical plant. Findings indicated, among other things, that students have a negative exchange value, that financial aid programs do not affect the exchange value of the student to the university, and that the universities that publish the most have relatively high marginal exchange values for research. These results are consistent with the hypotheses that universities maximize faculty consumption. They are inconsistent with maximizing prestige, profit, production or with valuing intrinsically academic activities. (JB)

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Economic Values Implicit in the Social Construction of American Universities

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April, 1991

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This paper was presented at the Annual Meeting of the American Educational Research Association in Chicago, Illinois in April, 1991.

The author, an Assistant Professor of Education at St. John's University, received his Ph.D. in Administration and Policy Analysis from Stanford University, where he studied the economics and sociology organizations, and a J.D. from the University of Utah.

William S. Massy, Henry M. Levin and Michael S. Garet made important contributions to my doctoral dissertation, which provided the basis for this paper. I can neither thank them enough nor hold them responsible for problems with the ideas as they have subsequently evolved.

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Abstract

Five economic hypotheses of what American universities value are tested to illustrate the implicit value framework, a conceptual framework for inferring the objective economic values of an organization from the manner in which society has defined its relationships of exchange and production. The results, very exploratory, are most consistent with James and Neuberger's hypothesis that university's maximize faculty consumption. They are inconsistent with maximizing prestige or production or of valuing intrinsically academic activities.

What do universities value? Do they maximize prestige? Do they value research more than instruction? Do they value first-professional programs, such as law and medicine more than undergraduate education? Are they faculty cooperatives that consume their resources in a manner pleasing to their faculty members? Do they intrinsically value the presence of distinguished faculty members and intellectual activities? These are the kinds of questions addressed in this paper. Just as importantly, this paper illustrates a conceptual framework for describing the value implications of the relationships that society defines between exchange and production in organizations. I present it through defining value and more particularly economic value as it applies to organizations in general and universities in particular and then discuss an exploratory study to estimate the values implicit in the activities of the population of universities in the United States that grant bachelor's, first-professional and research doctoral degrees as defined by the National Center for Education Statistics for the academic year 1982-1983.

Theoretical Framework: Value and Universities

There are many potential definitions of value. Value is sometimes synonymous with worth, preference, utility, a standard of estimation or exchange, or an equivalent. Implicit in each of the definitions is a preference for one or more things over one or more other things. The preference might be for certain principles over other principles, or certain activities over other activities, or, more generally, certain things over other things. For purposes of our study I will define the value of some thing or combination of things as a relative preference over other things or combinations of things.

Objective versus Subjective Value

Defining different types of value will clarify our discussion. First, let us distinguish between the values that an individual has in mind, called subjective values, and the values implicit in behavior, called objective values. I make this distinction in recognition of the differences that might occur between an individual's subjective beliefs and the behavior of the individual or an organization. Some of the theory of value developed by philosophers, economists and others does not make this distinction, easily leading their analyses of behavior to confound what actually

happens with what was desired by a particular person or group of people. Description can easily be obscured by normative assumptions. March and Simon's (1958, 169-171) concept of bounded rationality and Cohen, March and Olsen's (1972) garbage can model of decision-making remind us of the weakness of assuming a tight linkage between what happens and what particular decision-makers subjectively prefer. The distinction between objective and subjective value also has the benefit of making our question about what do universities value a sensible question. If values were only subjective, then a formal organization like a university could not have values to study. Rather, I would need to focus our attention on the subjective preferences of its participants, which, as I previously mentioned do not necessarily correspond to the actual behavior of a university.

My beliefs about the physical nature of existence support the assertion that the behavior of people and social collectives, such as universities and other formal organizations, have values implicit in them. It is widely believed that all behavior, including social behavior, is physically objectified, i.e., it manifests itself in time and space. This is an essential element not only of positivists, but of many other theorists, including theorists of socially constructed reality such as Berger and Luckmann (1967). My perception of physical reality is that many behaviors are mutually inconsistent with each other. You and I cannot stand in exactly the same place simultaneously. I cannot physically attend a conference in Chicago and physically teach a course in New York City at the same time. This mutual inconsistency of many physical behaviors forces physical tradeoffs that have implicit in them preferences of one behavior over another. In this sense there might even be values implicit in nature; nature appears to permit us to do certain things and not others and to produce certain sets of outcomes and not others. Additionally, some behaviors do not occur even without any apparent physical conflict with behaviors that do occur. Values are also implicit in this. When a professor teaches a concept in one manner, she does not teach it in any other way. Implicit in that behavior is a preference for one method over all other ones at that time and place.

I use "appears" to emphasize the possibility that any particular limit on what we can and cannot do is socially defined. As a society we limit our development of knowledge about the

world and develop new technologies in ways that are consistent with our shared beliefs and social institutions. This means that at least some of what appear to be natural limits to our actions are in fact socially defined limits that we could overcome through redefining shared beliefs and social institutions.

Intrinsic and Instrumental Value

We need to define another important distinction between two different types of value. The value of a thing will be either intrinsic, valued in and of itself, or instrumental, valued extrinsically for the value that results from it. This means that almost all analyses of social institutions and activities such as education are discussions of value. Most of them focus on instrumental value--how an individual or organization can accomplish something, such as teaching students. This is a very important concept; causation is a form of value. The manner in which we define technology determines much of the value, particularly the economic value, of resources and their owners.

For example, researchers in the University of California created an agricultural controversy when they developed a new strain of tomato that had a tough enough skin to be picked by a machine (Whyte & Boynton 1983). That research reduced the value of farmworkers in harvesting and increased the value of those who could design, manufacture, market, repair and operate the machinery. The researchers probably never even considered developing a new strain of tomato that would enhance the productivity of harvesting by farmworkers, which would have enhanced their value. Not only does this example demonstrate that causation is a form of value, but that as previously mentioned, values that appear to be implicit in the limitations of nature might merely reflect those of society.

The instrumental value of something is derived from the value of what it produces. The instrumental value of a school derives from the value of the cognitive development, socialization, custodial care and other outcomes of schools. The instrumental value of a faculty member derives from the value of the instruction, research and administration that the faculty member produces. The derivative nature of instrumental value means that ultimately nothing has instrumental value unless it leads to something that has intrinsic value. Universities do not have instrumental value

unless they lead to something that is valued intrinsically, such as knowledge, excellence or equality.

A particular object or activity can have both instrumental and intrinsic value. An individual can purchase a painting both because the individual values it in and of itself, intrinsic value, and as an investment, instrumental value.

The value of something can change with time, place and other circumstances. Values are not necessarily transitive. The constructs of economists and decision-theorists, often assume them to be transitive, but they need not be in reality.

Economic Value: The Implicit Value Framework

There are various possible frameworks for analyzing values that differ largely on the basis of the kinds of phenomena under consideration and the theories that define the perspective from which we look. The one that we will use, called the implicit value framework, is an economic one. It is expressed most completely in Olson (1990). The skeleton of the implicit value framework is the mathematical model of value maximization subject to production and financial constraints. Several economists have developed variations of it for theorizing about the microeconomics of organizations. Hopkins and Massy (1981, chapter 3) present the fullest treatment that I have found. The theory of the firm may be derived from that model as the special case for economic organizations. There are four principal differences between conventional frameworks of value maximization, such as that of Hopkins and Massy, and the implicit value framework proposed here.

The first difference is that there are no assumptions about the subjective values of the decision-makers who acquire and organize the resources of the organization, e.g., no assumption that the organization is maximizing profit, revenue, prestige or self-interest. Rather the organization's observable activities are examined for the objective values that are implicit in them.

The second difference is an inversion of the framework of value maximization for use as a basis for estimating the values implicit in the actual operations of organizations (William F. Massy of Stanford University and I have undertaken some preliminary work in this direction, where we

assumed a functional form for the value function). This is analogous to Laplace's inversion of probability to permit statistical inferences about causes from observations of their effects. Inversion of the framework of value permits empirical testing of many of the essential assumptions of microeconomic theory, such as the consistency of the objective values with the subjective values of an organization's various participants.

The third difference is that value is assumed to be implicit in the organization's definitions of production including its definitions of its different types of resources; production is not regarded as necessarily exogenous to the values of society, nor is it assumed to be maximized. The framework emphasizes that production functions and financial functions are not merely constraints but indicators of implicit value. Of course this makes explicit what is implicit in the conventional use of Lagrangian multipliers in modeling value maximization subject to constraints, which effectively make the constraints part of the value function.

The fourth difference is that the framework has a consistent approach based in organizational theory for identifying exchange and production relationships even in non-economic organizations that should permit comparative studies of various types of organizations both between and within societies. The theoretical consistency should permit studies of subunits to connect to each other as parts of studies of entire organizations, systems of organizations or perhaps societies. It should also permit the empirical results to provide insights into the disciplinary theories themselves, leading to further refinement, extension and integration.

Let me clarify some of these differences through reviewing some ideas from microeconomic theory. The theory of the firm and of consumer behavior are the central theories of microeconomics. They contain explicit value assumptions. In the theory of the firm, an entrepreneur maximizes profit through production and exchange of goods and services in markets with other firms and households. The goods and services are produced subject to technical constraints of production and the supply of inputs from and the demand for output for other firms and households. In the theory of consumer behavior, the consumer maximizes personal utility subject to a budget constraint and the supply of goods and services from firms. Values, including

personal utility, are exogenous. Profit is the explicit value of the firm and maximization of personal utility is the explicit value of the consumer. Maximization of profit and personal utility are only limited by each other and the constraints of technology as each individual decision-maker maximizes value with perfect knowledge.

Economists have long acknowledged the idealized nature of the assumptions of these theories of the firm and of consumer behavior and observed deviations from the idealized theory in practice. Here are a few examples of problems that economists have noted: 1) Principal-agent theory addresses the problem of an agent-entrepreneur who bases decisions on personal utility rather than the firm's profit. 2) Complex organizations make decisions through decision structures that aggregate values in complex ways. 3) Many organizations, such as government agencies and non-economic organizations are not even expected to maximize profit. 4) Individuals do not have perfect information about their personal preferences. 5) Preferences are revealed implicitly more than they are explicitly defined. 6) The framing of choices can reverse preferences. 7) Members of households are not united in their preferences. Also, 8) monopoly, monopsony, oligopoly, oligopsony and transactions costs reduce market efficiencies. 9) Where market discipline is imperfect, opportunism of individuals and groups can define inefficient technologies and lead to operation with slack. 10) Technology is not necessarily well understood, is constantly under exploration and can be problematic. 11) In non-economic organizations technology itself can be difficult to define and maximization of production might have little or no meaning.

Yet in the face of the ambiguity and confusion of life, social actors--households, firms, government agencies and other economic and non-economic organizations--depend on resources, i.e., goods and services, for all of their activities. Implicit in the manner in which they define resources and configure them into activities is a relative economic valuing of the goods and services that they utilize. This relative economic valuing can be estimated and related from one organization to another and even within subdivisions of a particular organization. It is an objective valuing in that it is derived from the observable activities of the organization itself rather than from the subjective preferences of any of the individuals within the organization. Estimates of the

objective values can then be compared with the subjective values of different individuals as well as other beliefs about the organization's activities to see how the objective behavior of the organization compares with the expectations of individuals and groups.

The Implicit Value Framework assumes that the instrumental economic values of an organization are 1) exchange and 2) production and that all value behavior not explained by the instrumental values reflects 3) intrinsic value. Some of the terminology is a little unconventional to emphasize 1) the importance of value in the concepts and 2) the presence of some assumptions unconventional to microeconomics; in particular, a) the objective nature of the economic values implicit in an organization and b) the socially defined nature of organizations.

The estimates of exchange value, productive value and intrinsic value can change with changes in circumstances. In particular, the estimates of the value of the last unit of a resource or an activity depends on the levels of the resources and activities of the organization. In the terms of economics, our discussion will focus on marginal value.

The implicit value framework assumes further that an organization results from a complex interaction of social processes, so that it is socially constructed. The actual behavior of a particular organization, such as a particular university, might well result more from laws, norms and customs of the society than from the subjective preferences of even its most influential participants.

The definition of objective value permits us to model mathematically the economic behavior of the university as value maximization subject to production relationships and financial constraints without assuming a priori the values to be maximized. Out of all of the ways in which society might have defined a university, out of all of the ways in which society might have defined the ways in which its activities will be organized into productive processes, out of all of the ways in which society might have financed the university's behavior, out of all of the operationalizations that could have resulted from the complex and structured interaction of its participants, only one actually occurs. Implicit in that preference is a maximization of value for the university. Note that values are implicit in the production and financial relationships themselves. They too are defined socially from among alternatives that are technically feasible. In short, we are modelling the

economic values of a university as the maximization of a value function subject to production and financial constraints, using a Langrangian function to make the production and financial constraints part of the objective function.

The exchange value of a particular object or activity is the total value of the objects and activities that the organization exchanges for it. Societies develop financing mechanisms to 1) facilitate exchanges or 2) alter the implicit exchange values of the parties to the exchange. Money is the principal socially defined convention of exchange. It permits a valuation of exchange in a standard unit, an objective valuation, such as dollars or pesos. For this reason, all of our estimates of economic value will be expressed in dollars. Nevertheless, while money primarily has instrumental value in our society, it also can have intrinsic value; individuals might well seek it for its own sake.

The productive value of an object or activity is the value of the other objects and activities that it produces in the organization. This means that it depends on the productive relationships that society has defined for the organization. The terms production and productive have connotations that might make some scholars of higher education and some participants in universities uncomfortable. Production usually connotes manufacturing or activity in some other enterprise where no intrinsic value is attached to either the resources or the activities. Many individuals have spoken of the processes that educate students or produce new knowledge as having value in and of themselves. We will use the term production, because we are utilizing an economic framework and in terms of economics, these are productive processes. Even in the culture of higher education faculty members are evaluated for their productivity, particularly their research productivity.

Our recognition that productive relationships in well established social institutions like universities, and even technology itself, are defined through many complex social processes over time provides a valuable insight into production in organizations: We can define two different types of production in order to understand more clearly the economics of an organization. The first type of production is technical production. It is what usually comes to mind when we speak of production. It involves chemical, mechanical or other physical changes in objects. The other kind

of production is institutional. It involves a social redefinition of the identity or attributes of an object as the result of some socially defined process, such as a lawsuit, or completion of a Ph.D. program. In institutional production, there might not be any change in the physical nature of the object, but members of society treat it differently. Most productive processes involve both technical and institutional production; they both change the object physically and redefine its meaning socially. For example, when a student completes a degree program in a college, society redefines the person as a college graduate and treats the person differently, assuming that there has been a change in actual physical attributes such as cognitive development of the individual. When the physical changes are hard to evaluate, then institutional production becomes more important. Society then seeks to regulate the definition of the process itself as the basis for justifying society's attribution of a different identity or other attribute. The outputs that universities produce are hard to evaluate technically, so the processes that produce them have been carefully defined by society through faculty socialization and governance, reaccreditation and other social processes.

Two clarifications seem appropriate in concluding this brief description of the implicit value framework. First, a study of objective value is not objective--the study is performed through the subjectivity of the researchers and understood through the subjectivity of the readers--but it has at least one less layer of subjectivity than a study of subjective value. Subjective values have to be objectified symbolically in speech, writing or gesture before they are accessible to the researcher and that adds at least one additional layer of subjectivity to the analysis; nevertheless, subjective value is also worth studying. Studies of the two forms of value complement each other.

Second, the implicit value framework is a conceptual framework not a theory. It does not present testable hypotheses about value; rather, it provides a conceptual framework for modeling, and proposing and testing hypotheses about, the objective economic values of actual organizations.

A Model of the Social Construction of a University

In order to study the productive values of the resources and activities of a university, we need to specify the productive relationships among them. We will base our model on institutionalized beliefs and practices of universities. We will assume, from Parsons (1960), that

universities have three levels of activities: technical, managerial and institutional. The technical level, or core, contains the activities that directly produce the output of the organization. In the case of a university, we will assume two parts to the technical core: instruction and research. The managerial level contains the activities that organize, coordinate and support the other activities of the university. The institutional level manages the external environment of the organization 1) to maintain the flow of essential resources, such as students and grants, and 2) to participate in the political and social processes potentially affecting the university, such as governmental rules and regulations.

The activities, or intermediate inputs, of the university we will organize according to standard accounting functions of the university because 1) they provide a reasonable set of categories, 2) the categories have become institutionalized in the decision processes of at least some universities, and 3) they correspond to the operational definitions used in the analysis. Our basic model of the productive relationships of the university is presented graphically in Figure 1.

<Insert Figure 1.>

From instruction the socially defined outputs are graduates from degree programs. From research, they are refereed publications, particularly articles. Of all of the goods and services that universities produce, graduates and publications are the ones that seem to us to have become institutionalized, or taken for granted by the organization's participants, as the most essential.

The basis of this model is at best exploratory and impressionistic. Additional research, particularly qualitative study, is needed of the social definitions of productive relationships to identify exactly how physical resources are combined into physical activities, how the activities affect each other, and how the activities produce the physical outputs of the university and the various attributes of the outputs. If we are correct in assuming that all behavior is physically objectified then we should be able to trace these relationships or at least the most essential ones.

The intrinsic value of an object or activity is its value that is not derived from its economic activity, in other words from its value in exchange or production. Almost our entire discussion

will concern marginal values, but it is awkward to continually include the adjective marginal. It will be understood that we mean marginal unless we are explicit about total or average value.

The Relationship between Exchange Value, Productive Value and Intrinsic Value

From our mathematical model of the economic values of a university (see Appendix A), I derive a condition that relates our three forms of economic value to each other for each object or activity. This condition can be stated in various ways depending upon the sign conventions in the model. It is easiest to understand intuitively if we differentiate between inputs and outputs. For inputs,

$$MIV = MEV-MPV.$$

In words the intrinsic value of an input equals the difference between its exchange value and productive value. An intuitive way of restating it is that when value is maximized, the university only sacrifices value in exchange for an input if that input has some combination of intrinsic value and productive value that is equivalent to the value sacrificed:

$$MEV = MPV+MIV.$$

For example, a university might hire a distinguished professor 1) for the revenue that the professor will generate through both instruction and research (MPV) and 2) in recognition of the professor's intellectual achievement and contributions to society (MIV). Implicit in hiring the professor is the equivalence between the value sacrificed, i.e. the professor's compensation, and the value obtained, i.e. the productive and intrinsic value of the professor.

Differences in sign conventions can lead to a different statement for outputs:

$$MIV = MPV-MEV.$$

In words, the intrinsic value of the last unit of output equals the resources that were redirected to produce it (MPV) minus the value given to the university for producing it (MEV). More intuitively, when a university directs resources to produce an output, it does so to receive as much value as it sacrifices in production. That additional value comes from 1) the revenue or other value that it receives for the output (MEV) and 2) the intrinsic value of producing the output (MIV). For example, when a university redirects faculty attention from instruction to research (MPV), it does it 1) to obtain the revenue that comes from sponsored research (MEV) and 2) to advance knowledge and enhance the university's prestige (MIV). The university is not maximizing value if it does not obtain intrinsic value and exchange value equivalent to the productive value that it sacrifices.

Five Hypotheses of the Economic Values of Universities

Our examination of the economic values of universities will be more meaningful through showing how it can be used to test several different assumptions of scholars who have suggested economic values for universities. The four hypotheses are universities maximize 1) profit like firms do, 2) production, 3) prestige, and 4) faculty consumption, and 5) they intrinsically value all academic resources and activities positively. I will describe each of these hypotheses in turn. The conditions of value maximization underlying the hypotheses are derived in Appendix B.

1. Profit--Sengupta (1975) assumes that universities maximize profit in his study of production and cost functions in universities. He probably does it to obtain the power of that assumption to simplify his analysis, but the assumption is worth examining to see the contrast between the values that are assumed for profit-maximizing firms and those assumed for universities. When a firm maximizes profit, none of the inputs or outputs has marginal intrinsic value; marginal exchange value equals marginal productive value.

2. Production--Carlson (1972) assumes that universities should maximize production. This is a normative assumption that many economists make in studying higher education. They are not necessarily aware of the inconsistency between the assumption of maximization of production and of other values often ascribed to universities (Clark 1983). Again, it is an assumption that

simplifies analysis. Production is maximized when none of the inputs has positive or negative intrinsic value.

3. Prestige--Breneman (1976) and Garvin (1980) both suggest that universities maximize prestige. Breneman makes this assumption in his well known study of the Ph.D. production process in academic departments. Garvin uses it to develop a model of the economic activity of universities. Their models of the production processes do not translate directly into our model, so we cannot test their hypotheses directly, but we can translate their central ideas into our model. They suggest that the prestige of universities depends on the prestige of faculty members; graduates, particularly from research-doctoral programs; and publications. In our model, this means that these resources and activities have positive intrinsic values.

4. Faculty Consumption--James and Neuberger (1981) describe the value function of universities as the maximization of faculty consumption. They assert that faculty members are not permitted to take home the revenues of universities as compensation or stock dividends, because of the non-profit nature of these enterprises, so instead faculty members consume the excess resources on themselves through expenditures within the university. James and Neuberger actually develop this model for the academic department but conclude by asserting its appropriateness for entire universities. The resources and activities that faculty members subjectively value intrinsically--themselves, libraries, departmental and academic support services, publishing and research doctoral programs--will have positive intrinsic values.

5. Academic Resources and Activities--The final hypothesis about the values of universities is suggested by our impression of the rhetoric of university officials, particularly presidents. Our impression is not based on careful scholarship; while I take this study seriously, our paper is meant to be more illustrative than definitive. It is our impression that university officials stress the intrinsic value of all academic resources and activities. Everything on the academic side of the university is pursued beyond its mere instrumental value; therefore in our model, students, degree programs, faculty members, libraries, departmental and other academic support services would all be intrinsically valued positively.

The implicit value framework permits us to compare the economic implications of these hypotheses about value with the actual but exploratory estimates of the objective values of the universities themselves.

Methodology

In the methodology section, I 1) define operationally the population, the typology of universities, the production variables and the marginal exchange values; 2) explore statistically the production variables and estimate marginal relationships between the production variables; 3) and then use the marginal productive relationships and the marginal costs and revenues to estimate the effective marginal intrinsic values of the inputs and outputs.

Population

The population for the study is the 166 comprehensive and research-doctoral universities, as classified by the National Center for Education Statistics (NCES) of the United States Department of Education, that enrolled students in bachelor's and first-professional degree programs in the fall of 1982 and awarded at least one research-doctoral degree in the 1982-3 academic year, according to the relevant Higher Education General Information Surveys for those years. A large number of universities have bachelors' and research-doctoral programs, but no first-professional degree programs. They have been eliminated from the population to overcome the bias in estimation resulting from having large numbers of zeros for 1) students in professional programs and 2) degrees in professional programs.

Each campus of a multi-campus university is treated separately as a university, consistently with the data reporting practices of NCES. I assume that the presence of research-doctoral programs implies at least some emphasis on research as an organized activity.

Data Sources, Collection and Estimation

Cross-sectional data is used, because resource limitations prevent extension of the analysis to more than one year. Since a period of longer than one year is required for the production of graduates and probably for the completion of a research project and publication of the results, it is assumed that the production processes of research and teaching are at an equilibrium, with an

annual cycle, and the levels of inputs and outputs remain approximately the same for every year. This assumption is weakest for activities measured in dollars in one fiscal year as opposed to another, since the prices of the same resources are not constant over time, but the differences should not interfere too greatly with the analysis given the exploratory nature of the study, since the changes from year to year are probably relatively small for an entire campus.

Most of the data used in the study comes from data sets routinely gathered from the institutions themselves and maintained by accounting or registration offices that emphasize consistency and reliability in their reporting practices.

Types of Universities

Universities are divided into four types--selective-private, selective-public, less selective-private, and less selective public--for purposes of estimation of production functions and analysis of the results. A university is typed as public if designated such in the survey of Institutional Characteristics of HEGIS for 1982, otherwise as private. A university will be designated as selective if its undergraduate program is classified as very competitive or better in Profiles of American Colleges (Barron's Educational Series, Inc. 1986) and as less selective otherwise. Unfortunately, this is a one-dimensional indicator of selectivity, since some universities have less selective programs at the bachelor's level and selective programs at graduate or professional levels, or vice versa. For example, the University of Minnesota is not classified as selective on this basis, even though its graduate programs were evaluated very favorably in the 1982 National Academy of Sciences' evaluations (Webster 1986).

The University of Pittsburgh and Temple University are treated as public universities, since they receive state appropriations and in return differentiate tuition on the basis of residency. Cornell University, the University of Pennsylvania and the Illinois Institute of Technology all differentiate tuition on the basis of residency in one or more of their graduate or professional programs and receive state subsidies in return, but in most of their programs they do not, so they will still be classified as private universities.

According to these definitions, there are 52 selective privates, 29 selective publics, 20 less selective privates, and 65 less selective publics. Appendix G, Table 24 of Olson (1989) contains an alphabetical listing of each university with an indication of its type as a characteristic variable.

Outputs and Inputs

The method of counting each of the outputs and inputs is described in the following paragraphs. The means and standard deviations of the distributions are set forth in Table 1 by each type of university. The complete listing of values for each university is in Olson (1989, Appendix G, Table 24).

<Insert Table 1.>

Graduates of Bachelor's Programs

The count of graduates of bachelor's programs was taken from line 417, columns four and five, of part B of the survey of Degrees and Other Formal Awards Conferred of HEGIS for 1982.

Graduates of First-professional Programs

The count of graduates from first-professional programs is taken from line fourteen, columns four and five, of Part A of the survey of Degrees and Other Formal Awards Conferred.

Graduates of Research-doctoral Programs

The count of graduates of doctoral programs is taken from line 417, columns eight and nine, of the survey of Degrees and Other Formal Awards Conferred. Academic master's degrees are treated as an intermediate step in the production of research-doctoral degrees and so excluded from the model.

Articles Published in Refereed Journals

The count of articles published in refereed journals was obtained by counting the articles listed under authors affiliated with a particular university publishing during 1983 from the Corporate Source section of the Arts and Humanities, Social Science, or Science Citation Indexes of the Institute for Scientific Information (ISI) or alternatively searching the same databases on-line in a roughly comparable manner.

Only the first authors are listed, so articles are only counted once in each data set. If the prestige of the author influences the ordering of the authors' names, then the counts will be biased toward universities with more prestigious faculty members. The Social Science Citation Index lists some articles which also appear in the Science Citation Index or the Arts and Humanities Citation

Index, so some double counting occurred. ISI would not reveal its estimates of the amount of overlap, although one employee volunteered that it was not more than 9 percent.

Students in Bachelor's Degree Programs

The count of students enrolled in bachelor's degree programs is the total full-time equivalents of such students, the sum of line one, columns thirteen and fourteen, and line fifteen, column fifteen, of the survey of Fall Enrollment of HEGIS for 1982.

Students in First-professional Programs

The count of students enrolled in first-professional degree programs is the total full-time equivalents of such students, the sum of line ten, columns thirteen and fourteen, and line twenty-four, column fifteen of the survey of Fall Enrollment. This does not include students enrolled in master's degree programs not classified as first-professional programs, such as in business, engineering, the arts, humanities and social sciences.

The assumption that masters degrees are not terminal degrees is particularly weak for business, where few students even seriously consider continuing beyond the MBA to a research-doctoral degree. This assumption confounds somewhat the relationships between graduate students and degrees. The pooling of data for estimation of production relationships should reduce the importance of the confounding through diluting the effect of the terminal masters' degrees, but a bias will remain.

Students in Research-doctoral Programs

The count of students enrolled in research-doctoral programs is the total full-time equivalents of all students in graduate programs other than first-professional degree programs, the sum of line eleven, columns thirteen and fourteen, and line twenty-five, column fifteen of the survey of Fall Enrollment. This includes students in academic master's degree programs, since such degrees are often intermediate steps toward research-doctoral degrees.

Full-time Faculty

The count of full-time faculty is the sum of men and women professors, associate professors, assistant professors and instructors from the Annual Report on the Economic Status of the Profession, 1982-1983 of the American Association of University Professors (AAUP), compiled under the direction of W. Lee Hansen from data collected by both NCES and AAUP. Where the data were missing for this year they were obtained from the comparable report for 1981-

82 or 1983-84. Data were not available for any of these years for four universities, Andrews University, Brigham Young University, St. John's University and Yeshiva University.

This is the number of full-time faculty members on either nine or twelve month contracts, since faculty members on nine month contracts often remain productive throughout all twelve months. Instructors, graduate assistants, and part-time faculty are not included in the counts, but they are represented in other departmental services, to the extent that they receive compensation for their services.

Other Departmental Administration and Services

The estimate of the support services to faculty and students of academic departments, such as staff, materials and supplies, is the sum of lines one and two of Part B of the survey of Financial Statistics of HEGIS for 1982, minus an estimate of total compensation to the full-time faculty members. Lines one and two include expenditures for both departmental instruction and research and sponsored research. The estimate of total compensation to faculty members for each university was computed by taking a count of full-time faculty members of each rank, multiplying it times the average salary for faculty members of that rank, summing across the ranks and multiplying the sum by one plus the fringe benefit rate. The counts and average salaries of faculty of each rank and the fringe benefit rate were taken from the Annual Report of the AAUP. This approach underestimates departmental services to the extent that faculty compensation is not included in departmental expenditures.

Academic Administration and Services

The proxy for academic administration and services is lines three plus four minus line five, Part B of the survey of Financial Statistics. It includes central academic administration separate from general university administration, academic computing centers, museums, art galleries, public television and radio stations, extension services and non-credit continuing education.

Library Services

The proxy for library services is the amount expended for libraries in one year from line five, Part B of the survey of Financial Statistics.

General Administration and Services

The proxies for both general support services and general administration are the expenditures for these activities for 1982. HEGIS does not separate these sets of expenditures

from each other, so they will be combined in estimating the model. The combined expenditures will be obtained from line seven, Part B of the survey of Financial Statistics.

Student Services

The proxy for student services is expenditures for non-departmental student services from line six, Part B of the survey of Financial Statistics.

Operation and Maintenance of Plant

The proxy for these services is expenditures for operation and maintenance of plant from line eight, part B of the survey of Financial Statistics. It includes utilities as well as expenditures for staff and equipment.

Equipment, Buildings and Land

The measurements of the inputs previously described do not include measurements of the capital--equipment, buildings and land--acquired in previous years and still in use on campus, since even the measurements of services are expenditures for one year only. Direct measurements of capital items are not available. The Financial Statistics survey of HEGIS asks for information about the replacement value of buildings, but very few of the universities responded. The survey of Financial Statistics contains book values for these items, but book values are a function of the time and place of the acquisition. For buildings and land, they are particularly problematic because of the long lives of these assets. For example, the book value of land for Stanford University is the value at which it was gifted in the Nineteenth Century. Buildings and land will not be included as inputs in estimating the model.

A shorter useful life makes book value a more meaningful number for equipment than for buildings, so it is included as a proxy for equipment in estimating the model. It is taken from Part C, line three, column five of the Financial Statistics survey of HEGIS for 1982.

Exchange Values

The marginal exchange value of a resource or activity is the sum of the marginal productive values and marginal intrinsic values of all of the resources and activities that were sacrificed to obtain it. Since the sum of the marginal productive value and marginal intrinsic value of an object or activity is the marginal exchange value of that object or activity, the marginal exchange value of a resource or activity also equals the sum of the marginal exchange values of all of the resources

and activities that were sacrificed. Data was not readily available to tie the resources to particular intermediate activities and intermediate activities are measured in the dollars that were exchanged for them, so for those intermediate activities the marginal exchange value is $10,000, the unit in which the analyses were conducted. The means and standard deviations of the marginal exchange values of the other resources and activities are set forth in Table 2. The method of determining the expected value of the marginal revenue or cost of each of the inputs or outputs is described in the following paragraphs.

<Insert Table 2.>

Graduates of Bachelors', First-professional or Research-Doctoral Programs

The marginal exchange values of graduates of bachelors', first-professional and research-doctoral programs is defined as the additional income not tied to increasing any particular input that the university receives for increased teaching activities in these programs. It is customary to tie income for teaching to changes in enrollment of students, rather than changes in levels of teaching activity or number of graduates. Income tied to changes in the levels of enrollment are negative marginal costs of students rather than marginal revenues of graduating students, so the marginal revenue of all three types of graduates is assumed to be zero.

Some grants and contracts might be in support of some instructional programs and so tied to levels of instruction generally. They would appropriately be treated as marginal exchange value of degree programs. They have been omitted from the study, due to the difficulty of identifying them for all of the universities in the study. While this will bias the results of the analysis somewhat, such programs are rare enough and small enough in magnitude that their omission should not affect the results importantly.

Articles Published in Refereed Journals

The expected value of the marginal exchange value of articles published in refereed journals is the total expenditures, direct and indirect and governmental and non-governmental, divided by the number of articles. The amount of total expenditures for research is taken from an annual survey of the National Science Foundation (1985). It includes research and development funding

for academic science, broadly defined to include the social sciences and education. It does not include grants in the humanities, so the estimates will be biased downward for universities receiving substantial research support in the humanities, but there probably are not many of these.

Students in Bachelors', First-professional and Research-doctoral Programs

The expected value of the marginal exchange value to the university of an undergraduate is the value that the university sacrifices to acquire an additional student from the university's external environment. This is operationally defined as being equal to the additional resources the university commits to financial aid minus the amount it receives in tuition and fees. Financial aid from non-university sources, such as federal and state grants and loans, is a price subsidy to the student and does not affect the exchange value to the university, so it is ignored in estimating exchange value. Most financial aid from university sources is in funds that are fixed in size, such as funds restricted to financial aid, and do not increase with an additional student, so these forms of aid are not included in estimates of the exchange value of students. The remaining funds are relatively unimportant in amount for most universities and difficult to identify and allocate among different types of students; they are not included.

Consequently, the marginal exchange value to the university of a student is the negative of the tuition the student pays. In public universities this amount usually differs between residents and non-residents. Presumably this reflects a different valuing of residents and non-residents, so each type of student is analyzed separately in the study. One private university, Brigham Young University, distinguishes in tuition between members and non-members of its sponsoring church. Only the member rate is used. This eliminates the need to perform a separate analysis for one private institution. The member rate was chosen instead of the non-member rate since data was not available to compute a weighted average and students are more likely to be members than not.

Estimating the marginal exchange value of students in public universities is complicated by the differing processes various states use to determine appropriations to public universities. Some states use enrollment as a basis for allocating appropriations among colleges and universities. This alters the marginal exchange value of students. Preliminary efforts to obtain such information

demonstrated its difficulty; they are not included in this study. This means that the exchange values of students for some public universities are biased negatively.

Estimating the exchange values of students is complicated further by the policy at some universities of using general funds to support students at the margin. Such expenditures should be included in the marginal exchange values of students, but the benefits from including that information did not offset the costs. This will probably have the largest effects on the estimates for doctoral students in private universities. General fund support of students that does not vary at the margin is a cost, but not a marginal cost and so should not be included.

Some universities subsidize auxiliaries, such as housing and food services. The marginal exchange values of students and faculty increase to the extent that the amount of these subsidies increases with each additional student or faculty member. The exact relationship between these subsidies and the exchange values of students and faculty are difficult to identify. The extent of such subsidies has decreased as auxiliaries have become self-supporting; leaving them out of the model should not grossly affect the results of the analysis.

The marginal exchange values of students in first-professional programs are more difficult to estimate because this classification is a composite of students in programs charging different rates of tuition. For example, tuition for law students might be $5000 and for dental students, $6000. The expected value of the marginal exchange values of first-professional students is operationally defined as the average tuition of such programs weighted by their corresponding full-time enrollments.

Tuition rates for students in bachelors' degree programs are taken from the Comparative Guide to American Colleges (1983) and tuition rates and enrollment levels for graduate and professional students are taken from the Guide to American Graduate Schools (1982). Experienced administrators author these publications, compiling tuition rates from bulletins of the universities, supplemented by informal surveys. Such secondary sources are not ideal, but should be adequate for the present exploratory analysis.

Where tuition rates are only expressed in dollars per unit of credit, the annual full-time rate is calculated by multiplying the tuition per credit by the required units of credit divided by an assumed number of years to completion. The assumed number of years to completion of a bachelor's degree is four; law degree is three; and other doctoral-level graduate and professional degrees, four. If separate tuition rates are not listed for first-professional degree programs, then the customary tuition rates for graduate students are used.

The marginal exchange values of students are estimated separately for 1) private universities, and for 2) residents and 3) non-residents of public universities.

Full-time Faculty

The expected value of the marginal exchange value to the university of a member of the faculty is the expected value of the compensation to the faculty. This is obtained from the Annual Report on the Economic Status of the Profession, 1982-3 (American Association of University Professors 1983). It is the average compensation of faculty members of the rank of professor, associate professor, assistant professor and instructor, plus the associated fringe benefits, weighted by the proportion of each. As for students, this does not necessarily include changes in subsidies to auxiliaries associated with changes in the size of faculty. However, some of these subsidies for faculty members might be captured in the benefits rate.

It also does not include subsidies tied to grants for research or instruction. The subsidies tied to grants for research have been included as marginal exchange value of research, since it is part of a package of revenue for the general research activity. If the data were available, it might be better to tie funding for research to each of the supported inputs, rather than the output.

Data on faculty compensation were unavailable for four of the universities: Andrews University, Brigham Young University, St. John's University and Yeshiva University.

All Other Inputs

The marginal exchange value of every other input, except equipment, is ten thousand dollars. That is the scaling of units used in calculating the marginal products. The marginal

exchange value of equipment is one thousand dollars--ten thousand divided by ten--to reflect a straight-line depreciation of ten years.

Productive Values and Intrinsic Values

Remember that the marginal productive value (MPV) of a resource or activity is the change in the productive value of the organization resulting from adding the last unit of the resource or activity. It is estimated by 1) defining a production function for the university, 2) estimating it for each type of university, 3) using the production function in a model of value maximization subject to production and financial constraints to derive a definition of marginal productive value in terms of marginal intrinsic value, marginal exchange value and the marginal productive relationships, 4) using the marginal productive relationships and the marginal exchange values to estimate the marginal intrinsic values, and 5) computing the marginal productive values from the marginal productive relationships, marginal exchange values and marginal intrinsic values.

A production function for institutional production has a different meaning than one for technical production. In technical production, the production function specifies the optimal level of production for a given level of inputs. In institutional production the function specifies the expected value of production for the given level of inputs. In estimating the production function, I assume that universities basically conform their production relationships to socially accepted conventions for universities of their particular type. For example, teaching loads of faculty members and sizes of classes are usually defined by professional conventions for universities of different types. In fact, many universities have lists of peer institutions that they use in evaluating the proper relative levels of resources. There is no assumption that these conventions are technically efficient; rather, the function is in terms of the expectation as a representation of the social convention.

For the functional form of production I have used the standard and most general specification of production relationships, which I call Shephardian joint production:

$$F(X,Y) = 0,$$

where X is a set of inputs and Y is a set of outputs. This functional form assumes that the organization can adjust all of the levels of the inputs and outputs except the last one which is then determined by the production function. It permits the university to equate the value relationships between all pairs of inputs and outputs:

$$MPV_{ik} = MRS_{ik} (MEV_k - MIV_k), \text{ for } i = 1 \text{ to } m \text{ and } k = 1 \text{ to } m, i <> k.$$

In words, this means that the marginal productive value of a particular resource or activity "i" relative to another resource or activity "k" equals the amount of change in "k" resulting from a one unit increase in "i" times the marginal productive value of "k" (remember that the marginal productive value of a resource or activity is its marginal exchange value minus its marginal intrinsic value). This relationship holds between every pair of inputs and outputs,with adjustments for the sign conventions of outputs. It assumes that the levels of all of the other inputs and outputs are held constant.

The marginal rates of substitution (MRS) of the inputs and outputs for Shephardian joint production were estimated using least principal components analysis (Olson 1989, 90-93) and are presented in Olson (1989, Tables 11-15). The theory of statistical inference--statistical significance and confidence intervals--for least principal components is being developed in a manuscript in process (Olson 1991) and is not yet available; therefore, the estimates should be received with appropriate caution. Table 3 sets forth a selection of some important relationships that are more intuitively grasped. Table 3 also contains average relationships to permit comparisons.

Only the first order changes have been estimated. In my judgment the exploratory and illustrative nature of the study argued against too much fine tuning of any of the analyses, although care was exercised throughout. The basic value and feasibility of the implicit value framework was being tested. Subsequent studies should more finely tune the analyses and estimation.

<Insert Table 3.>

These estimates are based on the assumption that all of the universities of a particular type tend toward the same basic production processes; if smaller ones were to increase their scale of operation in some way, such as increasing enrollment, they would do so in approximately the same manner as the larger ones had already done and vice versa. Some of the results surprise me. Despite the care that was exercised, they could be inaccurate estimates. For example, the estimate of the marginal relationship between bachelor's degrees and undergraduates for selective private universities suggests that as these universities expand the rate of graduation declines. Also, as both types of public universities increase in size, they have fewer research-doctoral graduates per graduate student. This result might reflect an increase in students in master's degree programs who do not pursue doctorates, or at least not in public universities. A final example, as both types of less selective universities increase in size, they publish fewer articles per faculty member.

The estimates of the productive relationships are used with the estimates of the exchange values to estimate the intrinsic values. The productive relationships, exchange values and intrinsic values are then used to compute the productive values. The estimation of intrinsic value and productive value are each discussed in turn.

Estimation of the Intrinsic Values

Our system of equations for marginal intrinsic values under Shephardian joint production is underdetermined by one equation. I assumed that four of the non-academic intermediate activities had no intrinsic value. The four were General Administration and Services, Student Services, Operation and Maintenance of Plant, and Equipment. The marginal intrinsic values for Shephardian joint production were then overdetermined. They were estimated from the estimates of the exchange values and the productive relationships through regression as described in Appendix C. Some of the estimates were then checked for correctness using the regression command in DataDesk Professional.

<Insert Table 4.>

Estimation of Productive Values

The definition of marginal productive value is the difference between the marginal exchange value and the marginal intrinsic value, with adjustments in the sign conventions for outputs. These were estimated by subtracting the estimates of marginal intrinsic value from the estimates of marginal exchange value for each university. They are identical for each type of university. Table 5 contains them. Apparently, the pooled marginal rates of substitution (MRS) eliminate any variance within type.

<Insert Table 5.>

Analysis of Results

Exchange Values

Table 2 includes some particularly interesting estimates of the marginal exchange values of the inputs and outputs. One of the most interesting is that students have a negative exchange value; students are inputs that pay to participate in universities. This is not so surprising given our beliefs that students are the ones who most benefit from participation making it appropriate for them to pay, but there are several reasons why we should not necessarily take this result for granted. First, the social returns to an educated citizenry and work force have been described by many authors, particularly the human capital theorists. Second, the universities in some countries recognize this enough not to charge their students for participation. Third, some public universities in this country, for example the University of California had implicitly recognized the value to society of enrolling students in colleges in its past practice of providing financial support to some students and not charging tuition to any students. Fourth, many universities in this country still pay, through scholarships and fellowships, their most able students to participate. Furthermore, the marginal exchange value determines the value that the university loses in acquiring an additional unit of the resource. A negative exchange value invites the university to enroll more students. It is interesting that universities stop expanding enrollment while students are still willing to pay large amounts to participate.

A further interesting implication of our estimate of the exchange value of students to the university is that most financial aid programs for students do not affect the exchange value of the student to the university, they only affect the exchange value to the student through subsidizing the student's participation in the university, or the ability of the student to finance the participation over time. Even most university scholarship programs do not affect the marginal exchange value of students because the universities take the money from a fixed pool that does not increase with the number of students admitted. The marginal exchange value of students only increases when the university has defined a policy of providing a fixed amount of scholarship or fellowship for each student admitted into a particular program, no matter how many students are admitted. For example, some universities have a policy of providing tuition and a stipend to every student admitted to particular research-doctoral programs.

Another particularly interesting estimate of marginal exchange value is the one for graduates; universities receive no revenues directly from graduating a student. They only receive direct income from admitting and enrolling them. Of course, students are not likely to continue to enroll if no one graduates, but the presence of financial incentives to enrolling students and the absence of financial incentives to graduate them, might encourage universities to keep students enrolled in a particular degree program as long as society, including the students, are willing to tolerate. I just mentioned that our society takes for granted that as long as the student is enrolled then the university needs to maintain appropriate productive relationships with other resources and activities, such as faculty, courses and support services. Taking this for granted might make universities regard the continued presence of a student as a cost and consequently cause universities to encourage students to leave, but the student is replaced with another student, and that undercuts the argument. It would be interesting to explore the implications for the behavior of universities of rewarding them for graduating students.

Another interesting exchange value worth analyzing is the value of publishing an article. Of course this is an unusual number for several reasons. First, articles are not the only publications; although, they are probably the most highly institutionalized in discussions of

research productivity. Second, our estimate is of the expected value of articles for the entire university, when in fact the revenues from producing them are concentrated much more heavily in the sciences. This raises the interesting question of how society comes to value objectively research in the sciences so much more than research in the social sciences and humanities, particularly in a society that expresses so much concern about its social problems. Third, not all research is necessarily published. Some of the research in some universities is classified. Fourth, the amount of money available for grants and contracts to support research is relatively fixed in total amount and will not necessarily increase with increased productivity. This also has important implications for research in universities. Fifth, the markets for allocating grants and contracts are not competitive in an economic sense. They either involve patronage or peer review.

It is interesting to see that the universities that publish the most also have relatively high marginal exchange values for research. Perhaps, this is because more money is available for research in the sciences and the sciences publish the most. Most of it is supplied by the government. This combination of observations raises interesting questions for further research about the relationship between the comparatively higher economic value that society places on research, the comparatively higher productivity in research and the briefer article length in the sciences. At one time all scholarly publication followed the same model, but over time the sciences moved to a different model. How much of that move resulted from technical differences and how much from additional economic incentives for productivity in research; what would have happened or what would happen if the exchange value of scholarship in the humanities or social sciences were as high?

Productive Values

The complexity of our estimates of productive values limits the depth in which we can analyze them in this exploratory and illustrative study; nevertheless, a few insights demonstrate the potential value of these estimates. In the conventional theory of the firm inputs and outputs have no intrinsic value and they have positive exchange values. The result is that outputs have negative productive values and inputs have positive productive values. In Table 5, seven of the sixteen

estimates for outputs are positive as one would expect in a conventional firm. Eighteen of the twenty-eight estimates for inputs are negative, as one would also expect. The estimates of productive values of the inputs and outputs of universities either underscore the complexity of the economic relationships among research and the various levels of instruction, or the imprecision of the estimates. I will assume the former for purposes of illustrating the meaning of marginal productive value.

There is one obvious potential source of the unconventional signs. The three inputs, students, that have the most impact on three of the outputs, degrees, have negative exchange values. That means that increasing degrees increases students and brings revenue into the university. However, only half (six of twelve) of the estimates are negative. Universities are sometimes modeled with enrollments as proxies for outputs rather than inputs. It would be interesting to see how the values of students changed with that model.

A positive productive value means that the last unit of increase in the input or output results in an increase in value to the university if you ignore the exchange and intrinsic values of the input or output itself. The marginal productive values of selective public universities are primarily negative (nine of eleven). This means that the last unit of increase in almost any input or output decreases value to the university, if you exclude from consideration the value of the input or output itself. The only two exceptions are Research-doctoral Degrees and Academic Support. Perhaps, selective public universities have overly expanded, except in research doctoral programs and academic support services.

On the other hand the marginal productive values of less selective public universities are primarily positive (seven of eleven). This means that the last unit of increase in any one of these inputs or outputs increases value to the university, if you do not consider the exchange and intrinsic values of the input or output itself. The exceptions are Articles, Graduate Students, Departmental Administration, and Academic support. This might suggest that less selective public universities underemphasize research, doctoral study and the associated academic support services.

The marginal productive value of professional degrees is unusually negative for all four types of universities except it is very positive for less selective public universities. Have these programs excessively expanded except in less selective public universities?

Remember that the marginal productive value of an input or output is the increase in value to the organization that is produced by a one unit increase in the input or output, excluding the input or output's own exchange and intrinsic values. Remember that technical relationships between, for example, the input and the other inputs and outputs do not necessarily cause the increase. They are more likely caused by social definitions of the relationships which I have called institutional production. For example, if a university increases its enrollment in its law school by forty students, it might well add an additional faculty member, additional books in the library to satisfy the faculty member, and additional support staff for the placement office. None of these increases is necessarily mandated technically by the enrollment increase; we do not understand well enough the technical relationships between university resources and physical changes in students. The increases are mandated by our institutional rules and shared beliefs about these relationships, including concerns about appearances of quality. We rely on these social definitions in part because we do not understand the technical relationships, but probably also as a reflection of other values of groups and individuals in society.

Intrinsic Values

I will first discuss some of the implications of specific estimates of intrinsic value (Table 4) and then analyze how the results compare with the five hypotheses of the economic values of universities. It is interesting that among the selective public universities the intrinsic value of resident students is positive and of non-residents is negative for students in both undergraduate and professional degree programs. The only difference between the estimation of the intrinsic values of resident and non-resident students is the difference between resident and non-resident tuition. It is surprising and perhaps coincidental that these differences would have just the right magnitude to imply a positive intrinsic value for residents and a negative one for non-residents. It is also interesting that graduate students have a negative intrinsic value for all types of universities.

The intrinsic values of faculty and all types of academic support services are positive. These intrinsic values are also quite consistent in magnitude across the different types of universities. The most obvious differences are the small intrinsic values for 1) faculty in the less selective private universities, 2) departmental administration in the more selective private universities and 3) library services in the less selective public universities.

For the outputs the most interesting contrast is between the selective private universities and the less selective public universities. The selective private universities have negative intrinsic values for all outputs, except bachelor's degrees, while the selective public universities have positive intrinsic values for all outputs except articles. All four types of universities place a nearly identical negative intrinsic value on publishing articles. This means that universities use revenues from research to cross-subsidize resources and activities other than research. They have surplus revenues as a result of the federal policy to reimburse the full rather than the marginal cost of research. Apparently, all types of universities value research for its exchange value rather than its intrinsic value.

Another interesting contrast is in the dramatic difference in less selective private universities between the intrinsic values of graduating students from professional degree programs and research-doctoral degree programs. These universities have a much more negative intrinsic value for graduates from professional degree programs than any other type of university and a much more positive intrinsic value for graduates from research-doctoral programs than any other type of university. Apparently, professional degree programs cross-subsidize research-doctoral programs. Implicit in that cross-subsidization is a very negative intrinsic valuing of professional degree programs and a very positive intrinsic valuing of research doctoral degree programs.

Let us now compare the results of our analysis with our five hypotheses of value. They depend on the intrinsic values of the inputs and outputs. I will do this in an impressionistic manner rather than through inferential statistics in recognition of the exploratory and illustrative nature of our analysis.

First, the intrinsic values of all four types of universities are inconsistent with the maximization of profit which, of course, is not the least bit surprising. If profit were being maximized then the intrinsic values of all of the inputs and outputs would be zero. Few of them are even close to zero.

Second, the intrinsic values of all four types of universities are inconsistent with maximization of production. If production were being maximized then the intrinsic values of all inputs would be zero. While the intrinsic values of some types of students are close to zero, the intrinsic values of faculty and all four types of academic services are very positive.

Third, the intrinsic values of all four types of universities are not completely consistent with the maximization of prestige. While our model of the production processes of universities is sufficiently different from those of Breneman and Garvin that we cannot test their hypotheses exactly, their explanations of their hypotheses stressed among other things the intrinsic value of graduates of research-doctoral programs, publications and faculty members. Three of our four types of universities did intrinsically value positively graduates of research-doctoral programs--only selective private universities did not. None of the types of universities intrinsically valued publications positively. In fact, all of them valued publications very negatively. It might be that faculty members subjectively value publications positively, but society does not provide adequate financial support to translate this subjective value of faculty members into an objective value of universities. In fact, universities do not even publish as much as a profit-maximizing organization would. All four types of universities intrinsically valued faculty members positively. The results are inconsistent with maximization of prestige, at least as operationalized, but we need additional study before completely dismissing this hypothesis; we need to study qualitatively how prestige is actually objectified in universities.

Fourth, the intrinsic values of all four types of universities might be consistent with the hypothesis of maximization of faculty consumption, depending on the subjective values of faculty members. The consistently strong positive intrinsic valuation of faculty members is certainly consistent with this hypothesis, as is the consistently strong positive intrinsic valuing of all four

types of academic support services. If faculty members value publishing then the negative intrinsic values of publications is inconsistent with faculty consumption. If faculty members intrinsically value participating in research-doctoral programs, then the positive valuation of graduating students from those programs for three of the four types of universities is consistent with maximization of faculty consumption. If faculty do not value instruction in other programs, then the negative valuation of most of the other degree programs is also consistent with maximization of faculty consumption. We need additional studies of the subjective values of faculty members to provide a more definitive answer to this hypothesis.

Finally, the intrinsic values of all four types of universities are inconsistent with our hypothesis that universities intrinsically value all academic resources and activities. All types of students for all types of universities are intrinsically valued negatively except for professional students in less selective private universities and resident undergraduate and professional students in selective public universities. Except for 1) graduates from less selective public universities, 2) research-doctoral graduates from selective public and less selective private universities, and 3) graduates from bachelor's degree programs in selective private universities, graduates from degree programs are intrinsically valued negatively. On the other hand, faculty members and academic support activities are intrinsically valued positively. Our impressionistic view that the rhetoric of universities is consistent with the positive valuing of all academic resources and support services is not consistent with the objective values of the universities. Again, additional scholarship is needed into the subjective values expressed in the rhetoric of higher education to determine how the values expressed would translate into actual resources and activities of universities. Then, we could more accurately state and test this hypothesis.

Conclusion

The implicit value framework provides a basis for analyzing the values of universities in terms of their economic implications, for comparing them with the subjective values of participants such as faculty members or administrators, for simulating changes in essential policy variables such as teaching loads and tuition rates, and for testing hypotheses about values. The framework

also provides theoretical insights into the meaning of value, particularly economic value, in an organization.

The results of this exploratory and illustrative study of the economic values of American universities suggest that universities do not maximize profit, production or prestige, and they value negatively many academic resources and activities. The estimates fit most closely James and Neuberger's hypothesis that universities maximize faculty consumption. They also raise questions for further research, for example about the negative objective intrinsic valuing of research and most levels of instruction. Of course, more careful studies should precede any reformulation of policy.

More importantly, the results underscore the potential for a research program that combines studies of the subjective values of participants and policy-makers in organizations with studies of the organizations' objective values using the implicit value framework as well as frameworks from other perspectives of value. The theoretically consistent basis of the implicit value framework permits studies of different levels and sectors of organizations to be combined for more complete insights into the value implications of organized society. In higher education, studies are possible at the level of households, academic and administrative departments, universities, and systems of universities.

Multi-level models are also possible to uncover interactions between organizational levels. For example, a model of a university could combine models of the academic and administrative departments to show their interdependencies and confluence. William F. Massy has developed and continues to refine a multi-level model that should provide valuable insights into the economics of universities.

All three forms of economic value--exchange, productive and intrinsic--provide insights into the values that society has defined for its resources and activities. The values of universities and other organizations are reflected in the price that they pay to acquire resources and activities, the productive relationships that the organization defines among them and the price that they receive for the goods and services that they produce. Implicit in the combination of these prices and productive relationships are positive and negative intrinsic values. The estimation of these values

provides an opportunity for researchers and policy-makers to get beneath the rhetoric and past the limitations of subjective beliefs to new levels of understanding about the behavior of complex organizations. Our society is becoming increasingly complex and organized. We need a deeper understanding of what we are doing. Cohen and March (1986) suggest that a university--and by implication other organized anarchies--are like vehicles skidding out of control. The implicit value framework provides measurements of the direction and speed of the skid.

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Appendix A

Extension of the Microeconomic Theory of Hopkins and Massy to Shephardian Joint Production

The Langrangian form of the theory, with Ω and μ as Langrangian multipliers, is

$$\text{Max } L = U(Z_1 \ldots Z_m) - \Omega F(Z_1 \ldots Z_m) + \mu G(Z_1 \ldots Z_m) \qquad (1)$$

The first order conditions for a maximum of the Langrangian are

$$\partial L/\partial Zi = \partial U/\partial Z_i - \Omega \partial F/\partial Z_i + \mu \partial G/\partial Z_i = 0 \quad \text{for i = 1 to m;} \quad (2)$$

$$\partial L/\partial \Omega = - F = 0; \text{ and}$$

$$\partial L/\partial \mu = G = 0.$$

Let $\partial U/\partial Z_i = U_i$, $\partial F/\partial Z_i = F_i$ and $\partial G/\partial Z_i = G_i$. After substituting these new symbols into equation (2) and rearranging terms we have

$$\Omega = (U_i + \mu G_i)/F_i \text{ and} \qquad (3)$$

$$U_k = \Omega F_k - \mu G_k. \qquad (4)$$

Substituting (3) into (4) gives

$$U_k = (U_i + \mu G_i)*F_k/F_i - \mu G_k \quad . \qquad (5)$$

Dividing (5) through by μ gives

$$U_k/\mu = (U_i/\mu + G_i)*F_k/F_i - G_k \; . \qquad (6)$$

Rearranging terms gives

$$-(U_k/\mu + G_k) = -F_k/F_i * (U_i/\mu + G_i) \; . \qquad (7)$$

This can be restated in terms of our notation of MIV, MEV, and MRS, where $MRS_{ik} = -F_k/F_i$:

$$-(MIV(X_k) - MEV(X_k)) = MRS_{ik}*(MIV(Y_i) + MEV(Y_i)) \qquad (8)$$

There are $m*(m-1)/2$ such conditions, but the rank is only m-1, since they result from the m-1 ratios between the m variables. This was checked through Gaussian elimination for up to 4 variables with 6 equations.

Appendix B

Derivations of Alternative Hypotheses of Value Maximization Assuming Shephardian Joint Production

I. Profit maximization

U=G so

$\partial U/\partial Z_i = \partial G/Z_i$ for i = 1 to m.

Let $\partial G/\partial Z_i = G_i$. Substituting this into equation 6 of Appendix A gives

$G_k/\mu = (G_i/\mu + G_i)*F_k/F_i - G_k$ for i=1 to p+n and k = 2 to p+n and i<k (6)

After collecting terms,

$(1+1/\mu)*G_k = (1+1/\mu)*G_i*F_k/F_i$.

Then divide both sides by $(1+1/\mu)$;

$$G_k = G_i * F_k / F_i \, .$$

This is the traditional economic assumption of profit-maximization. All of the MIV's equal zero.

II, III and IV Other Hypotheses of Value Maximization

The other hypotheses imply that some inputs or outputs are in the value function and others are not. The ones that are in the value function are valued positively. We will assume that the partial derivative of the value function with respect to a positively valued variable is positive. The partial derivative of the value function with respect to a variable not in the value function is obviously zero; its changes cannot directly affect the value function.

Appendix C

Solving for Marginal Intrinsic Values (MIV's) Assuming Shephardian Joint Production

Equation (7) of Appendix A states

$$-(U_k/\mu + G_k) = -F_k/F_i*(U_i/\mu + G_i) \quad . \qquad (7)$$

Rearranging terms and multiplying both sides of equation (7) by F_i gives

$$1/\mu(F_i*U_k - F_k*U_i) = -(F_i*G_k - F_k*G_i) \quad . \qquad (9)$$

There are m*(m-1)/2 such conditions. We can assume that k is less than i without loss of generality, and so if

$$\mathbf{A} = \begin{vmatrix} F_2 & -F_1 & 0 & 0 & \ldots 0 & \ldots 0 & \ldots 0 & 0 \\ F_3 & 0 & -F_1 & 0 & \ldots 0 & \ldots 0 & \ldots 0 & 0 \\ F_4 & 0 & 0 & -F_1 & \ldots 0 & \ldots 0 & \ldots 0 & 0 \\ 0 & F_3 & -F_2 & 0 & \ldots 0 & \ldots 0 & \ldots 0 & 0 \\ 0 & F_4 & 0 & -F_2 & \ldots 0 & \ldots 0 & \ldots 0 & 0 \\ & & & & \ldots & & & \\ 0 & 0 & 0 & 0 & \ldots F_i & \ldots -F_k & \ldots 0 & 0 \\ & & & & \ldots & & & \\ 0 & 0 & 0 & 0 & \ldots 0 & \ldots 0 & \ldots F_m & -F_{m-1} \end{vmatrix} ,$$

$$\mathbf{U} = 1/\mu \begin{vmatrix} U_1 \\ U_2 \\ \dots \\ U_m \end{vmatrix}, \text{ and}$$

$$\mathbf{G} = \begin{vmatrix} G_1 \\ G_2 \\ \dots \\ G_m \end{vmatrix},$$

then

$$\mathbf{AU} = -\mathbf{AG} \qquad (10)$$

Table 1

Means and Standard Deviations of Variables of Production

	Selective		Less-Selective	
	Private (n=52)	Public (n=29)	Private (n=20)	Public (n=65)
Means				
Bachelors' degrees	1,372	3,642	988	2,472
Professional degrees	309	277	216	204
Research doctoral degrees	137	273	42	129
Articles in journals	701	1,193	95	468
Undergraduates	5,856	16,798	4,891	13,371
Professional students	1,055	996	711	732
Graduate students	2,186	3,664	904	2,020
Faculty	560	1,129	329	821
Dept'l admin. & services	7,476	13,318	2,218	6,697
Academic support	921	2,752	339	1,900
Library admin. & services	467	769	170	416
Student services	475	763	308	518
General admin. & services	1,248	1,743	640	925
Operations & maintenance	1,189	2,066	560	1,190
Equipment	7,104	12,968	2,137	6,572
Standard Deviations				
Bachelors' degrees	837	1,919	750	1,200
Professional degrees	200	220	151	173
Research doctoral degrees	129	193	56	116
Articles in journals	740	848	119	470
Undergraduates	3,895	8,390	4,901	6,065
Professional students	710	781	468	638
Graduate students	1,766	2,360	755	1,461
Faculty	320	541	230	356
Dept'l admin. & services	6,926	8,194	1,962	4,757
Academic support	1,075	1,979	632	1,577
Library admin. & services	363	461	140	222
Student services	317	550	330	345
General admin. & services	987	1,085	543	604
Operations & maintenance	1,033	1,262	613	704
Equipment	7,243	8,340	2,312	4,823

From dept'l admin. & services to equipment, the variables are in units of $10,000.

Table 2

Means and Standard Deviations of Marginal Exchange Values (MEV) by Type of University

(dollars)

	Selective		Less-Selective	
	Private (n=52)	Public (n=29)	Private (n=20)	Public (n=65)
Means				
Bachelors' degrees	0	0	0	0
Professional degrees	0	0	0	0
Research doctoral degrees	0	0	0	0
Articles in journals	51,429	62,236	33,084	49,564
Undergraduates	-6,196	-1,213	-4,530	-1,074
Non-resident		-3,335		-2,714
Professional students	-5,298	-1,336	-4,083	-1,358
Non-resident		-3,360		-2,943
Graduate students	-4,596	-996	-3,287	-861
Non-resident		-2,671		-1,959
Faculty	47,292	50,028	41,546	41,932
Standard Deviations				
Bachelors' degrees	0	0	0	0
Professional degrees	0	0	0	0
Research doctoral degrees	0	0	0	0
Articles in journals	80,605	30,919	32,577	30,727
Undergraduates	1,630	437	1,169	426
Non-resident		1,174		778
Professional students	1,836	762	1,751	829
Non-resident		1,813		1,734
Graduate students	1,211	407	944	394
Non-resident		1,046		711
Faculty	8,883	8,070	9,502	5,879

Departmental admininistration and services, academic support, library administration and services, student services, general administration and services, operations & maintenance and equipment all have values of $10,000.

Table 3

Selected Shephardian Marginal Rates of Substitution (MRS's) and Average Productive Rates by Type of University

	All	Selective		Less Selective	
		Private (n=52)	Public (n=29)	Private (n=20)	Public (n=65)
Marginal Rates of Substitution					
Bachelor's Deg/Undergraduate	0.096	-0.768	0.258	0.580	0.209
Prof'l Degrees/Prof'l Students	0.317	0.287	0.254	0.344	0.285
Res Doct'l Deg/Grad Students	0.034	0.042	-0.096	0.127	-0.140
Articles/Faculty	0.101	2.021	0.831	-0.366	-1.629
Average Productive Rates					
Bachelor's Deg/Undergraduate	0.207	0.234	0.217	0.202	0.185
Prof'l Degrees/Prof'l Students	0.288	0.293	0.279	0.303	0.278
Res Doct'l Deg/Grad Students	0.066	0.063	0.074	0.046	0.064
Article/Faculty	0.865	1.253	1.056	0.287	0.570

Table 4

Means and Standard Deviations of Marginal Intrinsic Values (MIV's) by Type of University

(dollars)

	Selective		Less-Selective	
	Private (n=52)	Public (n=29)	Private (n=20)	Public (n=65)
Means				
Bachelors' degrees	221	-5,345	-4,075	1,282
Professional degrees	-17,152	-7,723	-48,107	13,224
Research doctoral degrees	-6,893	5,896	42,764	3,041
Articles in journals	-51,162	-69,114	-60,910	-50,281
Undergraduates	-6,027	164	-2,165	-1,342
Non-resident		-1,958		-2,998
Professional students	-353	623	12,452	-5,129
Non-resident		-1,401		-6,714
Graduate students	-4,305	-431	-8,737	-437
Non-resident		-2,106		-1,534
Faculty	46,602	55,745	28,154	40,764
Dept'l admin. & services	7,940	18,929	18,998	12,154
Academic support	10,011	9,087	7,958	10,362
Library admin. & services	12,788	18,507	15,335	7,150
Standard Deviations				
Bachelors' degrees	0	0	0	0
Professional degrees	0	0	0	0
Research doctoral degrees	0	0	0	0
Articles in journals	79,813	30,919	30,634	30,486
Undergraduates	1,630	437	1,169	426
Non-resident		1,174		781
Professional students	1,836	762	1,751	829
Non-resident		1,813		1,734
Graduate students	1,211	407	944	394
Non-resident		1,046		711
Faculty	8,707	8,070	8,988	5,879
Dept'l admin. & services	0	0	0	0
Academic support	0	0	0	0
Library admin. & services	0	0	0	0

Student services, general administration and services, operations & maintenance, and equipment are all assumed to have marginal intrinsic values of zero.

Table 5

Estimates of Shephardian Marginal Productive Values (MPV's) by Type of University

(dollars)

	Selective		Less Selective		
Output/Input	Private (n=52)	Public (n=29)	Private (n=20)	Public (n=65)	
Bachelors' degrees	221	-5,345	-4,075	1,282	
Professional degrees		-17,152	-7,723	-48,107	13,224
Research doctoral degrees	-6,893	5,896	42,764	3,041	
Articles	340	-6,878	-36,593	-717	
Undergraduates	-170	-1,377	-2,364	269	
Professional students		-4,928	-1,959	-16,535	3,771
Graduate students	-291	-565	5,450	-425	
Faculty	688	-5,718	13,392	1,168	
Dept'l admin. & services	2,060	-8,929	-8,998	-2,154	
Academic support	-11	913	2,042	-362	
Library admin. & services	-2,788	-8,507	-5,335	2,850	

The marginal productive values of student services, general administration and services, operations and maintenance, and equipment are all assumed to be $10,000.

Figure 1

Diagram of Model of Joint Production in Universities